

CLAIMS

What is claimed is:

- 1 1. A method of selectively creating chains for a virtual interface, the method comprising
2 the computer-implemented steps of:
3 selecting a first number from a set consisting of zero and one;
4 selecting a second number from a set consisting of zero and one;
5 creating, on a network element, as many encapsulation chains for a particular virtual
6 interface as are indicated by the first number; and
7 creating, on the network element, as many decapsulation chains for the particular
8 virtual interface as are indicated by the second number.
- 1 2. A method as recited in Claim 1, wherein the first number is zero and the second
2 number is one.
- 1 3. A method as recited in Claim 1, wherein the first number is one and the second
2 number is zero.
- 1 4. A method as recited in Claim 1, wherein the first number is zero and the second
2 number is zero.
- 1 5. A method as recited in Claim 1, wherein the step of selecting the first number
2 comprises the steps of:
3 determining whether at least one physical port of a particular card of the network
4 element (a) is configured to send data packets of a type that would be
5 produced by an encapsulation chain for the particular virtual interface and (b)
6 can send data packets toward a destination associated with the particular
7 virtual interface; and

8 if no physical port of the particular card (a) is configured to send data packets of a
9 type that would be produced by an encapsulation chain for the particular
10 virtual interface and (b) can send data packets toward the destination
11 associated with the particular virtual interface, then selecting the first number
12 to be zero.

1 6. A method as recited in Claim 1, wherein the step of selecting the second number
2 comprises the steps of:
3 determining whether at least one physical port of a particular card of the network
4 element is configured to receive data packets of a type that would be
5 processed by a decapsulation chain for the particular virtual interface; and
6 if no physical port of the particular card is configured to receive data packets of a type
7 that would be processed by a decapsulation chain for the particular virtual
8 interface, then selecting the second number to be zero.

1 7. A method as recited in Claim 1, wherein the steps of selecting the first number and
2 selecting the second number comprise the steps of:
3 determining whether a plurality of cards of the network element includes a
4 specialized card that is designed to perform a type of data packet processing
5 that would be performed by one or more chains for the particular virtual
6 interface; and
7 if the plurality of cards includes a specialized card that is designed to perform a type
8 of data packet processing that would be performed by one or more chains for
9 the particular virtual interface, then selecting the first number to be zero and
10 selecting the second number to be zero.

1 8. A method as recited in Claim 1, wherein the step of selecting the first number
2 comprises the steps of:
3 determining whether at least one physical port of a particular card of the network
4 element (a) is configured to send data packets of a type that would be
5 produced by an encapsulation chain for the particular virtual interface and (b)

6 can send data packets toward a destination associated with the particular
7 virtual interface;
8 determining whether a plurality of cards of the network element includes a
9 specialized card that is designed to perform a type of data packet processing
10 that would be performed by one or more chains for the particular virtual
11 interface; and
12 if at least one physical port of the particular card (a) is configured to send data
13 packets of a type that would be produced by an encapsulation chain for the
14 particular virtual interface and (b) can send data packets toward the
15 destination associated with the particular virtual interface, and the plurality of
16 cards does not include any specialized card that is designed to perform a type
17 of data packet processing that would be performed by one or more chains for
18 the particular virtual interface, then selecting the first number to be one.

1 9. A method as recited in Claim 1, wherein the step of selecting the second number
2 comprises the steps of:
3 determining whether at least one physical port of a particular card of the network
4 element is configured to receive data packets of a type that would be
5 processed by a decapsulation chain for the particular virtual interface;
6 determining whether a plurality of cards of the network element includes a
7 specialized card that is designed to perform a type of data packet processing
8 that would be performed by one or more chains for the particular virtual
9 interface; and
10 if at least one physical port of the particular card is configured to receive data packets
11 of a type that would be processed by a decapsulation chain for the particular
12 virtual interface, and the plurality of cards does not include any specialized
13 card that is designed to perform a type of data packet processing that would be
14 performed by one or more chains for the particular virtual interface, then
15 selecting the second number to be one.

1 10. A method as recited in Claim 1, wherein the first number and the second number are
2 selected based on user input.

1 11. A method of selectively creating chains on a plurality of cards of a network router,
2 the method comprising the computer-implemented steps of:
3 for each particular card within the plurality of cards, performing the steps of:
4 for each particular virtual interface of the particular card, performing the steps
5 of:
6 determining whether at least one physical port of the particular card is
7 configured to send data packets of a type that would be
8 produced by an encapsulation chain for the particular virtual
9 interface;
10 determining whether at least one physical port of the particular card is
11 (a) configured to receive data packets of a type that would be
12 processed by a decapsulation chain for the particular virtual
13 interface and (b) can send data packets toward a destination
14 associated with the particular virtual interface;
15 determining whether the plurality of cards includes a specialized card
16 that is designed to perform a type of data packet processing
17 that would be performed by one or more chains for the
18 particular virtual interface;
19 if the plurality of cards includes a specialized card that is designed to
20 perform a type of data packet processing that would be
21 performed by one or more chains for the particular virtual
22 interface, then using no resources of the particular card to
23 create an encapsulation chain and a decapsulation chain for the
24 particular virtual interface;

25 if no physical port of the particular card is configured to send data
26 packets of a type that would be produced by an encapsulation
27 chain for the particular virtual interface, then using no
28 resources of the particular card to create an encapsulation chain
29 for the particular virtual interface;
30 if no physical port of the particular card is configured to receive data
31 packets of a type that would be processed by a decapsulation
32 chain for the particular virtual interface, then using no
33 resources of the particular card to create a decapsulation chain
34 for the particular virtual interface;
35 if at least one physical port of the particular card (a) is configured to
36 send data packets of a type that would be produced by an
37 encapsulation chain for the particular virtual interface and (b)
38 can send data packets toward the destination associated with
39 the particular virtual interface, and the plurality of cards does
40 not include any specialized card that is designed to perform a
41 type of data packet processing that would be performed by one
42 or more chains for the particular virtual interface, then using
43 resources of the particular card to create an encapsulation chain
44 for the particular virtual interface; and
45 if at least one physical port of the particular card is configured to
46 receive data packets of a type that would be processed by a
47 decapsulation chain for the particular virtual interface, and the
48 plurality of cards does not include any specialized card that is
49 designed to perform a type of data packet processing that
50 would be performed by one or more chains for the particular
51 virtual interface, then using resources of the particular card to
52 create a decapsulation chain for the particular virtual interface.

1 12. A method of selectively creating chains on a plurality of cards of a network router,
2 the method comprising the computer-implemented steps of:
3 selecting, from the plurality of cards, one or more first cards that each have at least
4 one physical interface that is configured to send data packets that conform to a
5 first protocol;
6 selecting, from the plurality of cards, one or more second cards that each have at least
7 one physical interface that is configured to receive data packets that conform
8 to a second protocol;
9 creating, on each of only the one or more first cards, an encapsulation chain for a
10 virtual interface that is associated with encapsulating data packets that
11 conform to the second protocol within data packets that conform to the first
12 protocol; and
13 creating, on each of only the one or more second cards, a decapsulation chain for a
14 virtual interface that is that is associated with encapsulating data packets that
15 conform to the second protocol within data packets that conform to the first
16 protocol.

1 13. A computer-readable medium carrying one or more sequences of instructions for
2 selectively creating chains for a virtual interface, which instructions, when executed
3 by one or more processors, cause the one or more processors to carry out the steps of:
4 selecting a first number from a set consisting of zero and one;
5 selecting a second number from a set consisting of zero and one;
6 creating, on a network element, as many encapsulation chains for a particular virtual
7 interface as are indicated by the first number; and
8 creating, on the network element, as many decapsulation chains for the particular
9 virtual interface as are indicated by the second number.

1 14. A computer-readable medium as recited in Claim 13, wherein the first number is zero
2 and the second number is one.

- 1 15. A computer-readable medium as recited in Claim 13, wherein the first number is one
2 and the second number is zero.
- 1 16. A computer-readable medium as recited in Claim 13, wherein the first number is zero
2 and the second number is zero.
- 1 17. A computer-readable medium as recited in Claim 13, wherein the step of selecting the
2 first number comprises the steps of:
3 determining whether at least one physical port of a particular card of the network
4 element (a) is configured to send data packets of a type that would be
5 produced by an encapsulation chain for the particular virtual interface and (b)
6 can send data packets toward a destination associated with the particular
7 virtual interface; and
8 if no physical port of the particular card (a) is configured to send data packets of a
9 type that would be produced by an encapsulation chain for the particular
10 virtual interface and (b) can send data packets toward the destination
11 associated with the particular virtual interface, then selecting the first number
12 to be zero.
- 1 18. A computer-readable medium as recited in Claim 13, wherein the step of selecting the
2 second number comprises the steps of:
3 determining whether at least one physical port of a particular card of the network
4 element is configured to receive data packets of a type that would be
5 processed by a decapsulation chain for the particular virtual interface; and
6 if no physical port of the particular card is configured to receive data packets of a type
7 that would be processed by a decapsulation chain for the particular virtual
8 interface, then selecting the second number to be zero.

- 1 19. A computer-readable medium as recited in Claim 13, wherein the steps of selecting
2 the first number and selecting the second number comprise the steps of:
3 determining whether a plurality of cards of the network element includes a
4 specialized card that is designed to perform a type of data packet processing
5 that would be performed by one or more chains for the particular virtual
6 interface; and
7 if the plurality of cards includes a specialized card that is designed to perform a type
8 of data packet processing that would be performed by one or more chains for
9 the particular virtual interface, then selecting the first number to be zero and
10 selecting the second number to be zero.
- 1 20. A computer-readable medium as recited in Claim 13, wherein the step of selecting the
2 first number comprises the steps of:
3 determining whether at least one physical port of a particular card of the network
4 element (a) is configured to send data packets of a type that would be
5 produced by an encapsulation chain for the particular virtual interface and (b)
6 can send data packets toward a destination associated with the particular
7 virtual interface;
8 determining whether a plurality of cards of the network element includes a
9 specialized card that is designed to perform a type of data packet processing
10 that would be performed by one or more chains for the particular virtual
11 interface; and
12 if at least one physical port of the particular card (a) is configured to send data
13 packets of a type that would be produced by an encapsulation chain for the
14 particular virtual interface and (b) can send data packets toward the
15 destination associated with the particular virtual interface, and the plurality of
16 cards does not include any specialized card that is designed to perform a type
17 of data packet processing that would be performed by one or more chains for
18 the particular virtual interface, then selecting the first number to be one.

1 21. A computer-readable medium as recited in Claim 13, wherein the step of selecting the
2 second number comprises the steps of:
3 determining whether at least one physical port of a particular card of the network
4 element is configured to receive data packets of a type that would be
5 processed by a decapsulation chain for the particular virtual interface;
6 determining whether a plurality of cards of the network element includes a
7 specialized card that is designed to perform a type of data packet processing
8 that would be performed by one or more chains for the particular virtual
9 interface; and
10 if at least one physical port of the particular card is configured to receive data packets
11 of a type that would be processed by a decapsulation chain for the particular
12 virtual interface, and the plurality of cards does not include any specialized
13 card that is designed to perform a type of data packet processing that would be
14 performed by one or more chains for the particular virtual interface, then
15 selecting the second number to be one.

1 22. A computer-readable medium as recited in Claim 13, wherein the first number and
2 the second number are selected based on user input.

1 23. An apparatus for selectively creating chains for a virtual interface, comprising:
2 means for selecting a first number from a set consisting of zero and one;
3 means for selecting a second number from a set consisting of zero and one;
4 means for creating, on a network element, as many encapsulation chains for a
5 particular virtual interface as are indicated by the first number; and
6 means for creating, on the network element, as many decapsulation chains for the
7 particular virtual interface as are indicated by the second number.

1 24. An apparatus for selectively creating chains for a virtual interface, comprising:
2 a network interface that is coupled to a data network for receiving one or more packet
3 flows therefrom;

4 a processor;
5 one or more stored sequences of instructions which, when executed by the processor,
6 cause the processor to carry out the steps of:
7 selecting a first number from a set consisting of zero and one;
8 selecting a second number from a set consisting of zero and one;
9 creating, on a network element, as many encapsulation chains for a particular
10 virtual interface as are indicated by the first number; and
11 creating, on the network element, as many decapsulation chains for the
12 particular virtual interface as are indicated by the second number.